Pulses in Rotation

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Farm Facts

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Grain producers frequently report high cereal yields the year following a pulse crop such as field pea, lentil, or faba bean. Relative yield benefit varies year-to-year and is partially due to high levels of and more readily available nitrogen in residues of pulse crops. Considerable additional benefit appears to come from various 'rotational effects'.

Effect on Cereal Yield

On average, cereals yielded higher on pulse residues than on cereal residues, but both cropping sequences gave lower yields than sowing cereals on fallow (Table 1). Crop sequence studies at Melfort, Scott, and Saskatoon have shown that cereal yields were higher on field pea than on lentil residue. An eight year study at Brandon and six year study at Melfort showed that faba bean residue gave higher barley yields than residues of other pulses. Overall, cereal yields were highest after fallow followed in order by faba bean, field pea, lentil, and cereal.

Melfort data showed an additional yield benefit the second year after production of a pulse crop (Table 2). In comparison to continuous cereal production, the pulse-barley-wheat sequence gave a 21% higher barley yield in year one and 12% higher wheat yield in year two. No tests have been carried out to show whether or not the yield benefit from pulses extends beyond two subsequent years.

Under conditions of moisture stress, as shown in Table 3, pulses may give no yield benefit and in some cases may actually reduce yield of subsequent cereal crops. Reasons for this yield reduction are unknown, but possibly relates to lack of snow trapping by pulse residues.

The yield benefit of pulses to subsequent cereal crops was equivalent to 65 kg N/ha over 16 trials at Brandon, Melfort and Scott. However, pulse residues usually contain a maximum of 25 kg N/ha more than cereal residues. Additional yield increases are due to 'rotational effects' which may include such factors as soil physical condition, growth enhancing properties released from pulse residues, and stimulation of nutrient release from the soil.

Table 1. Relative cereal yields for various cropping practices in the Black and Dark Brown soil zones of Saskatchewan

Preceeding Crop	Cereal Yield (as % of yield on cereal stubble)
Fallow	138
Field pea	128
Lentil	122
Cereal + N*	117
Cereal	100

*Scott, 45 kg N/ha; Melfort, 50 kg N/ha; Saskatoon, 40 kg N/ha

Table 2. Yields of barley and wheat in Years 1 and 2 following barley and pulse crops on Melfort silty clay loam and Waitville loam

Preceeding Crop	Year 1 Barley Yield* kg/ha	Year 2 Wheat Yield* kg/ha
Faba bean	3490	2350
Field pea	3440	2400
Lentil	3340	2300
Barley	2840	2030

*Mean of 5 nitrogen fertility levels

Fertilizing Cereals After Pulses

Cereals following pulses should be fertilized similarly to cereals following cereals. Figure 1 shows that the pattern of yield response of barley to nitrogen fertilizer on both types of residue was practically the same for nitrogen fertilizer rates up to 100 kg/ha. At higher nitrogen fertilizer rates and under conditions of moisture stress, yield response to nitrogen was greater on barley than pulse residues. Maximum yield was attained with less added nitrogen on pulse than barley residues.

Nitrogen fertilizer alone was unable to bring yields on barley residue up to the maximum yield attained on pulse residues, thus confirming that the benefit from the pulse crop is not only to be found in the added nitrogen it provides to the succeeding crop.

Effect on Cereal Quality

Increased barley protein content and kernel weight is associated with increased nutritional value. Pulse residues increased both protein content and kernel weight of subsequent cereal crops. Table 4 shows that protein content on pulse residues was similar to fallow. In order to bring the protein content of barley on barley stubble to the level of barley grown on pulse residues, approximately 100 kg N/ha was required. Protein content of wheat grown on wheat stubble, pulse residues or fallow was similar.

While the increase in protein content is nutritionally beneficial under some conditions, it may reduce the chance of producing barley of desirable malting quality. However, the Melfort study did show that pulse residues increased kernel plumpness by 5%, thereby increasing the chance that the sample would be acceptable for malting.

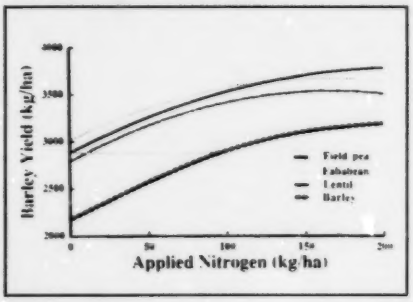
Effect on Production Efficiency

Pulse-barley-wheat crop sequences were considerably more productive than the barley-barley-wheat sequence in terms of net energy production and economic gross margin to cash costs at Melfort. For example, the sequence including field pea used only 60% as much production energy for fuel, fertilizer, and herbicides as the cereal sequence. Energy and economic advantages of pulse crops appear to be closely related to adequate moisture in succeeding years and the relative value of pulse and cereal crops.

Table 4. Protein content of cereals in several cropping sequences

Preceding Crop	Cereal Protein Content (%)		
	Barley at Brandon	Barley at Melfort	Wheat at Saskatoon
Fallow	11.5	—	15.7
Faba bean	11.5	11.9	—
Field pea	—	11.8	15.5
Lentil	—	12.0	15.2
Cereal*	9.0	11.2	15.4
Cereal* + N**	11.6	11.9	—

*barley at Brandon and Melfort; wheat at Saskatoon
**120 kg N/ha at Brandon; 100 kg N/ha at Melfort



Summary

The value of including pulses in rotation is related to moisture. Under conditions of moisture stress, pulses may reduce yield of subsequent cereal crops, while in favorable conditions, large yield increases can be anticipated. Lack of data from the Brown soil zone prevents applying the following conclusions to that area. Assuming there is adequate moisture for good cereal production, it is concluded that:

1) cereal yield is greater following fallow〉 pulse 〉cereal

2) the pulse benefit lasts at least two years

3) yield increases are due both to 'rotational effects' and to extra nitrogen from pulse residue

4) similar rates of nitrogen fertilizer should be used for cereal grown on cereal and pulse residues

5) pulses increase nutritional quality of subsequent barley crops

6) pulses in rotation increase net energy production and economic return.

Table 3. Relative yield of cereals on pulses as compared to cereal on cereal

	Relative yield of cereal on pulses (%)	Growing conditions
Barley		
1985 Waitville loam	148	normal
1986 Waitville loam	88	spring moisture stress
Wheat		
1985 Waitville loam	122	normal
1985 Elstow silty clay loam	101	moisture stress

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